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(54) A mandrel and flow control valves for well tubing

(57) A mandrel 10 includes a side-pocket 24 and a locking shoulder 26 aligned with the pocket. A plurality 12 of vertically connected flow control valves, such as gas lift valves, each having an inlet and an outlet are adapted to be positioned in the pocket by a single latch 42 connected to the valves engaging the locking shoulder 26. The pocket has a vertical length sufficient for receiving the valves, a plurality of vertically spaced openings 52, 54, extending between the interior of the pocket and the outside of the mandrel, one of the openings 52, 54 being positioned adjacent each of the inlets 32, 38 of the valves 30, 36 when the valves are installed, and a plurality of passageways 56, 58 extending between the interior of the pocket and the interior of the mandrel with one of the passageways being positioned to communicate with each of the outlets 34, 40 of said valves when the valves are installed.

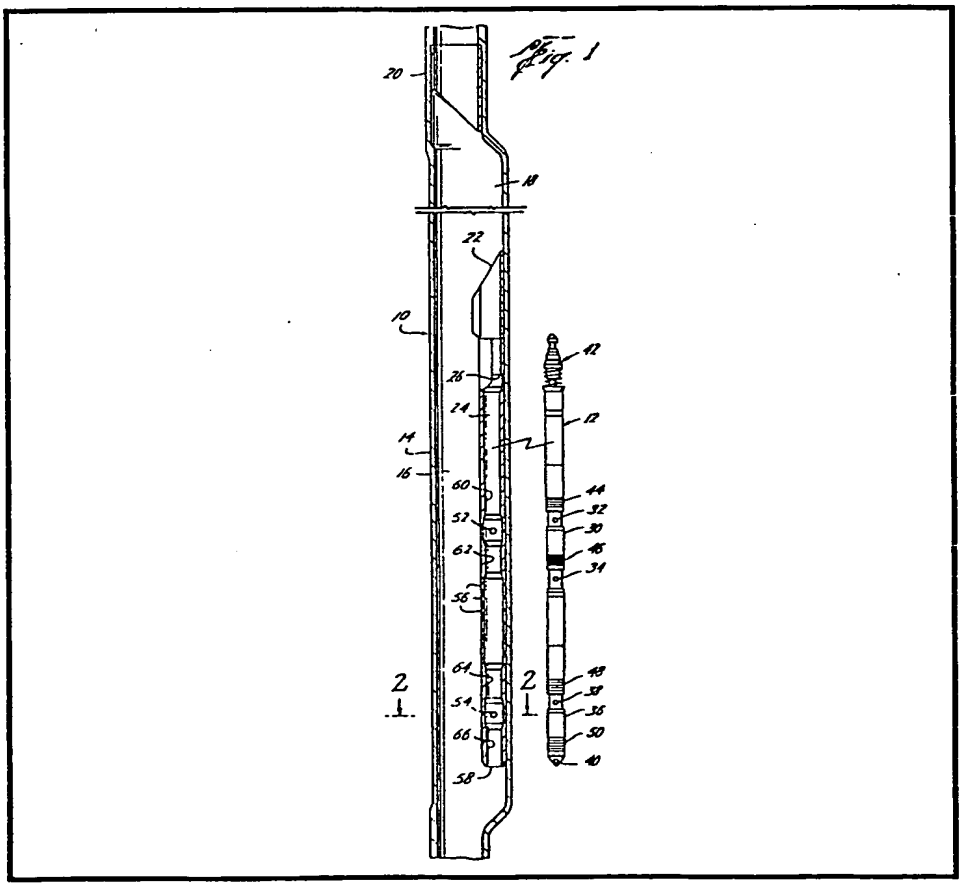

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Fig. 3B

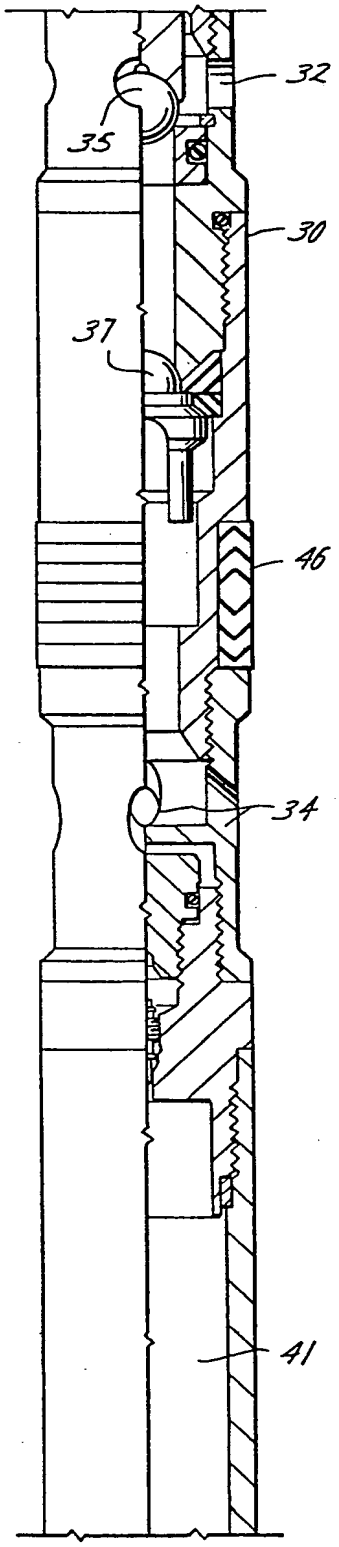


Fig. 3C

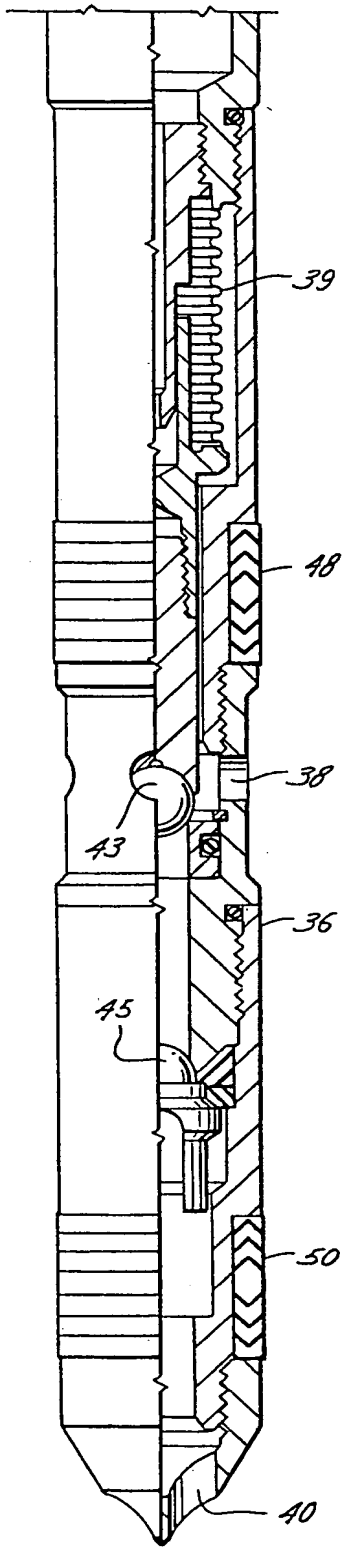


Fig. 5B

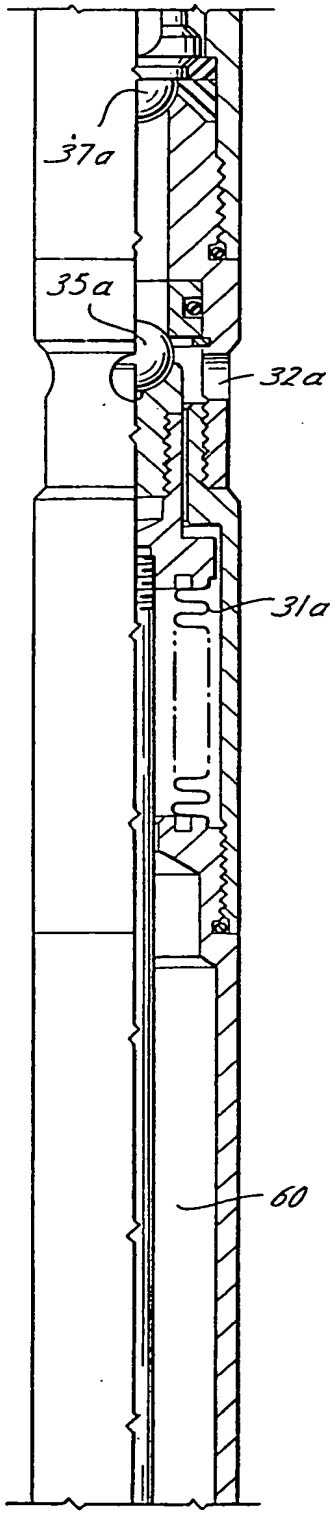


Fig. 5C

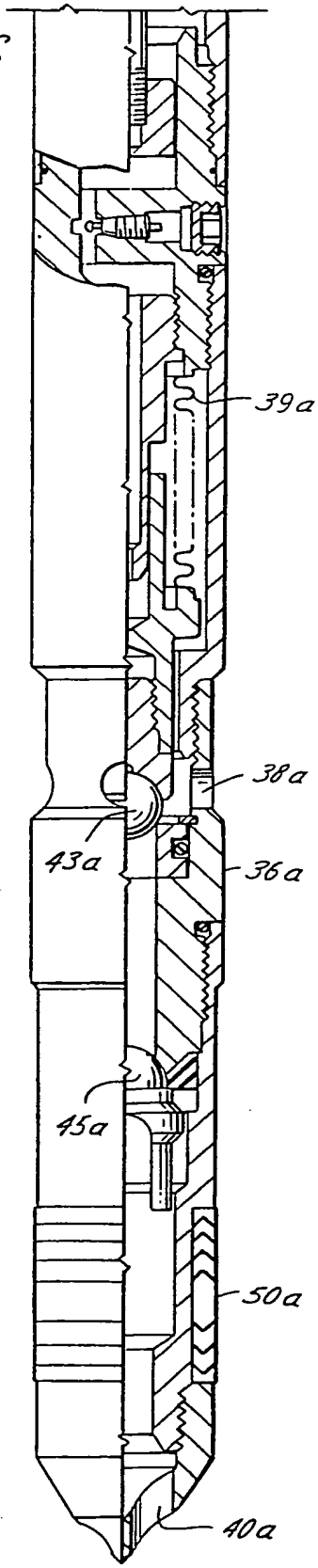


Fig. 6C

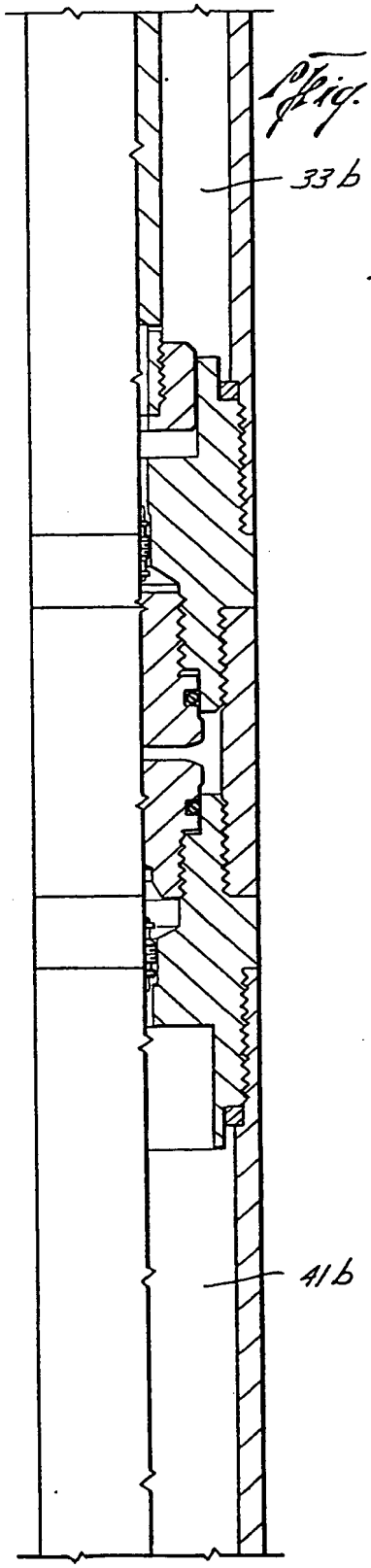
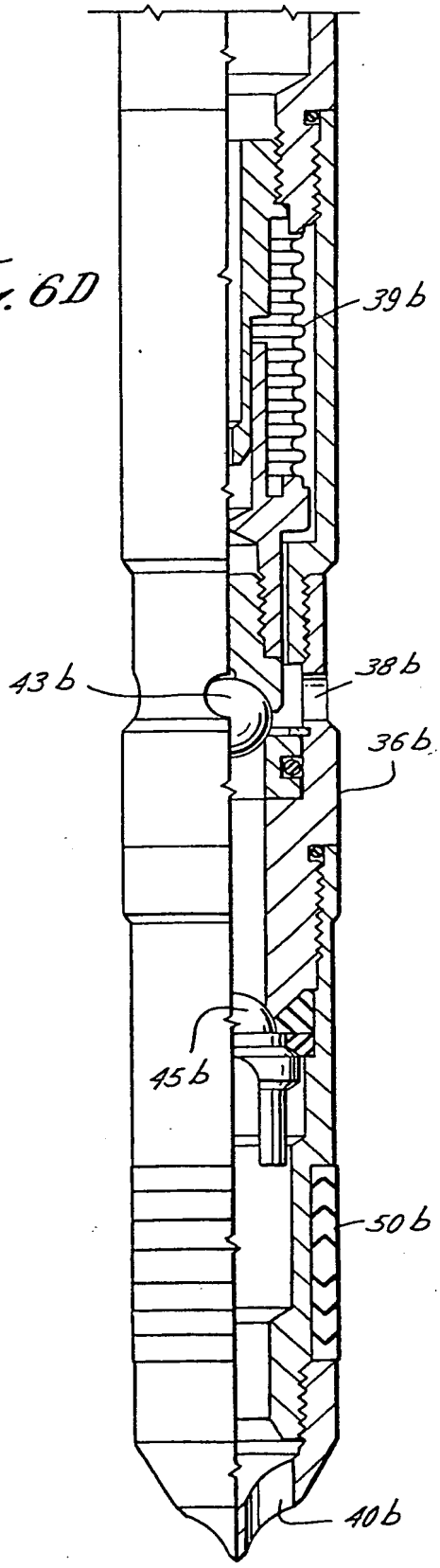


Fig. 6D



Figures 6A, 6B, 6C and 6D are continuations of each other of an enlarged elevational view, partly in cross-section, of a further embodiment of a multiple valve assembly for use in the mandrel shown in Fig. 4.

While the present invention will be described in connection with the use of multiple gas lift valves, it will be understood this is for purposes of illustration only and the multiple valves may be of other types such as injection valves or kill valves.

Referring now to the drawings, particularly to Figs. 1 and 2, the reference numeral 10 generally indicates the improved mandrel of the present invention and the reference numeral 12 generally indicates the improved multiple flow control valve assembly of the present invention.

The mandrel 10 generally includes a body 14 having an open bore 16 extending therethrough for alignment with a well tubing into which the mandrel is inserted by threaded connections (not shown) and an offset bore 18. The mandrel 10 also includes an orienting sleeve 20 in the main bore 16, a discriminating deflector guide 22, a sidepocket 24 and a locking lug or shoulder 26. As described in U.S. Patent No. 3,741,299, the orienting sleeve 20 is used to orient a kickover tool into alignment with the sidepocket 24 for removing or installing a valve therein or therefrom, and the deflector 22 guides a valve, but prevents other well tools from catching in the pocket or on an installed valve.

The mandrel 10 is generally installed in an outer casing (not shown) which limits the size of the body 14 as well as the size of the pocket 24 and a valve therein. However, it is desirable to obtain greater valve areas, such as in gas lift operations, to obtain a greater flow of lifting gas. The present invention is directed to providing a multiple flow control valve assembly 12, an improved mandrel 10, and the combination thereof. Generally, the valve assembly 12 consists of a plurality of flow control valves, such as gas lift valves, which are axially aligned and connected together for insertion and removal from the sidepocket 24, and the sidepocket 24 is designed to coact with the valve assembly 12 which has the advantages of (1) increasing the valve control area thereby increasing the volume of gas controlled by the valve assembly 12, (2) allowing a single down well trip to be made to install or remove the plurality of valves in the assembly 12, and (3) requiring only a single lock for latching the multiplicity of valves in the sidepocket.

The valve assembly 12 includes a first valve 30 having an inlet 32 and an outlet 34, and a second valve 36 having an inlet 38 and an outlet 40. The valves 30 and 36 are axially aligned and vertically connected together whereby they can be jointly installed, removed, or locked in the pocket 24 by means of a conventional lock 42 such as the Camco Type BK–2 which coacts with the locking shoulder 26 to releasably latch the valve assembly 12 in the sidepocket 24. The valve assembly 12 also includes packing seals 44 and 46 which are above and below the inlets 32 of valve 30, respectively, and packing seals 48 and 50 which are above and below the inlets 38 of valve 36, respectively, thereby isolating the valves 30 and 36 from each other.

The sidepocket 24 is of a vertical length sufficient for receiving the plurality of vertically connected flow control valves 30 and 36. The valve pocket 24 also includes a plurality of vertically spaced openings 52 and 54 extending between the inside of the pocket 24 and the outside of the body 14 of the mandrel 10. The openings 52 are positioned to be adjacent the inlet opening 32 of the valve 30, and the openings 54 are positioned to be adjacent the inlets 38 of the valve 36 when the assembly 12 is installed in the sidepocket 24. A plurality of passageways 56 and 58 extend between the interior of the pocket 24 and the interior of the body 14 of the mandrel 10 with passageway 56 being in position to communicate with the outlets 34 of valve 30 and passageway 58 being in position to communicate with the outlet 40 of valve 36. The interior of the valve pocket 24 also includes polished sealing surfaces 60, 62, 64 and 66 for coacting with the seals 44, 46, 48, and 50, respectively.

Figs. 3A, 3B and 3C comprise an enlarged view of the valve assembly 12 of Fig. 1. Preferably, the gas lift valves 30 and 36 are o the pressure charged bellows type. In valve 30 a bellows 31 is actuated by pressure in a pressure charged chamber 33 to move a valve element 35 into a closed position. When sufficient gas pressure is applied to the inlets 32 overcoming the pressure charged bellows 31, the valve element 35 moves to the open position allowing the flow of gas through the inlet 32 through a check valve 37 and out of the outlets 34. Similarly, valve 36 includes a pressure charged bellows 39 actuated by pressure in a chamber 41 acting in a direction to move a valve element 43 into a closed position as best seen in Fig. 3C. When sufficient gas is applied through the inlets 38 and against the bellows 39, the valve element 43 is moved to the open position and gas flows from the inlet 38 through the check valve 45 and out of the outlets 40.

The mandrel 10 and valve assembly 42 as described above is the preferred embodiment as the valve inlets and outlets are positioned below the bellows whereby the bellows is not subjected to settling debris, each valve 30 and 36 has its own pressure charged chamber 33 and 41, respectively, so that the valves may be individually adjusted, and the valves

3. A mandrel as claimed in Claim 1 wherein the pocket includes a sealing surface on each side of each vertically spaced opening for isolating the valves from each other.

4. A mandrel as claimed in Claim 1 wherein the number of openings is two, a sealing surface is provided above and below said two openings, and wherein the number of passageways is two and one is positioned above the upper sealing surface and the other is positioned below the lower sealing surface.

5. The combination of a mandrel and multiple flow control valves for use in a well tubing comprising, a mandrel having a body with an open bore extending therethrough for alignment with the well tubing and having an offset bore adjacent the open bore, orientation means in the open bore, a pocket positioned inside the body in the offset bore, a deflector guide positioned in the offset bore above the pocket, a locking shoulder secured in the body and aligned with the pocket, a plurality of vertically connected flow control valves each having an inlet and an outlet for positioning in the pocket, a single latch connected to the valves for engagement with the locking shoulder for locking the valves in the pocket, said pocket being of a vertical length sufficient for receiving the valves, a plurality of vertically spaced openings extending between the interior of the pocket and the outside of the body, one of said openings being positioned adjacent each of the inlets of said valves when the valves are installed, and a plurality of passageways extending between the interior of the pocket and the interior of the body, one of the passageways being positioned to communicate with each of the outlets of said valves when the valves are installed.

6. The combination as claimed in Claim 5, wherein each passageway is positioned below one of the openings.

7. The combination as claimed in Claim 5 wherein the pocket includes a sealing surface on each side of each vertically space opening for isolating the valves from each other.

8. The combination as claimed in Claim 5, wherein the number of openings is two and including a sealing surface in the pocket above and below said two openings, and wherein the number of passageways is two and one is positioned above the upper sealing surface and the other is positioned below the lower sealing surface.

9. The combination as claimed in Claim 5, wherein each of the valves are gas lift valves having a pressure charged bellows acting against a valve element in a direction to close said valve.

10. The combination as claimed in Claim 9, wherein the bellows of said valves is pressure charged from a single pressure chamber.

11. The combination as claimed in Claim 10, wherein the number of gas lift valves is two and the chamber is positioned between the two bellows, one of the bellows acts upwardly on its valve element and one of the bellows acts downwardly on its valve element, a single seal is provided around the valves above the valve inlets, and a single seal is provided around the valves below the valve inlets.

12. The combination as claimed in Claim 9, wherein the number of gas lift valves is two, one of the bellows acts upwardly on its valve element and one of the bellows acts downwardly on its valve element, a single seal is positioned around the valves above the valve inlets, and a single seal is positioned around the valves below the valve elements.

13. A gas lift valve assembly for positioning in the side pocket of a mandrel having a locking shoulder aligned with the pocket comprising, two gas lift valves, each having an inlet and an outlet, and a pressure charged bellow connected to a valve element, said valves being axially aligned and connected together, a single lock connected to said valves for locking with said shoulder for holding the aligned valves in the pocket.

14. An assembly as claimed in Claim 13, wherein the assembly includes a single gas charged chamber connected to each of the bellows.

15. An assembly as claimed in Claim 13, wherein the outlet of each valve is positioned above the inlet of each valve, and a seal is positioned around each valve on both sides of each inlet.

16. An assembly as claimed in Claim 13, wherein the inlets of each valve are positioned adjacent each other with the outlet of the upper valve directed upwardly and the outlet of the lower valve directed downwardly, and a seal is positioned around each valve above and below said two inlets.

17. The combination of a mandrel and multiple flow control valves for use in a well tubing, substantially as hereinbefore described with reference to the accompanying drawings.

CLAIMS (19 May 1980)

1. The combination of a mandrel and multiple flow control valves for use in a well tubing comprising a mandrel having a body with an open bore extending therethrough for alignment with the well tubing and having an offset bore adjacent the open bore, orientation means in the open bore, a pocket positioned inside the body in the offset bore, a deflector guide positioned in the offset bore above the pocket, a locking shoulder secured in the body and aligned with the pocket, a plurality of vertically connected but independently actuated gas lift valves each having an inlet and an outlet for positioning in the pocket, each said valve having a pressure charged bellows positioned above and acting downwardly against a valve element in a direction to close